REMARKS

This amendment is responsive to the Office Action of January 2, 2003. Reconsideration of claims 1-17 and 23 is respectfully requested.

The Office Action

The Restriction Requirement was made Final. Accordingly, claims 18-22 are canceled without prejudice.

Claim 1 was provisionally rejected under the doctrine of obviousness-type double patenting over claim 1 of copending Application Serial No. 09/642,901 in view of Tasaki, et al. (U.S. Patent No. 6,319,425).

Claim 2 was provisionally rejected under the doctrine of obviousness-type double patenting over claim 3 of copending Application Serial No. 09/642,901 in view of Tasaki, et al.

Claim 7 was provisionally rejected under the doctrine of obviousness-type double patenting over claim 1 of copending Application Serial No. 09/642,901 in view of Tasaki, et al.

Claims 1-7, 9-16, and 23 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Lowery (U.S. Patent No. 5,959,316) in view of Tasaki, et al.

Claims 5 and 14 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Lowery and Tasaki, et al.

Claims 8 and 17 stand rejected under 35 U.S.C. §103(a) as being unpatentable over Lowery and Tasaki, et al. in view of Kamiyama, et al. (U.S. Patent No. 5,787,104).

Claim 23 stands rejected for the same reasons as claim 10. The Examiner takes the position that the process of manufacturing is incidental to the claimed apparatus.

The Double Patenting Rejection Should Be Withdrawn

Claim 1 of the present application now calls for a light source including a light emitting component which emits light when a voltage is applied and a phosphor-containing material positioned to receive light emitted by the light emitting component. The intensity of the light varies across the light emitting component at the applied voltage. ***The phosphor-containing material has a thickness which varies in proportion to the intensity of the light emitted by the light emitting component*** at the applied voltage. The uniformity of color emission is improved as compared with a uniform thickness layer.

Claim 1 of the copending 09/642,901 application has now been canceled.

Claim 2 of that application, however, calls for a light source comprising a light emitting component which emits light when a voltage is applied, an intensity of the light varying across the light emitting component at the applied voltage. A layer of a phosphor material is positioned to receive light emitted by the light emitting component, the phosphor material converting at least a portion of the light to light of a different wavelength. ***A layer of a light transmissive material spaces the phosphor material from the light emitting component, the thickness of the layer of light transmissive material varying across the light emitting component in proportion to the intensity of the light emitted by the light emitting component at the voltage.***

The Examiner argues that it would have been obvious in view of Tasaki, et al. to include the thickness of the copending application as having a thickness changing with the intensity of the light. Applicants respectfully traverse.

Applicants submit that Tasaki does not disclose having a thickness which varies in relation to the intensity of the light and further, that it would not be obvious to modify claim 2 of the 09/642,901 application, as the Examiner suggests, in view of Tasaki.

The Examiner points to col. 8, lines 63-65, **Tasaki, et al.** where it is suggested that the thickness of the fluorescent cap may be partially varied to diffuse the light or to change the color of the light. The Examiner argues that Tasaki shows that the thickness of the fluorescing layer, when partially varied, **changes the intensity** of the emitted light and thus it would be obvious to include the thickness of the phosphor layer as changing **with the intensity**. Tasaki changes the intensity of the light output from the lamp by shaping the fluorescent layer as a lens (See Fig. 5 and col. 5, lines 29-44). In this way, more light is emitted axially, and less light is emitted to the sides. Clearly, the focussed light of Tasaki is not varying in proportion to the light emitted by the LED, but is substantially increased, in the axial direction, and is substantially decreased at an angle to the axis, as compared with the emitted light.

There is no suggestion in Tasaki of providing a cap with a thickness which varies **in proportion** to an intensity of the light emitted by the light emitting component at an applied voltage. Due to the presence of connectors and other features, the light emitted from an LED does not follow the curved profile of the Tasaki's cap of FIGURE 5. Rather, as illustrated in FIGURE 6 of the present application, peaks in light intensity are spaced by regions of no or little light output. The crude variations in the thickness of Tasaki's cap are thus not proportional to the light output.

Rather, to improve light distribution, **Tasaki, et al.** uses a diffusion material in a cap of uniform thickness (see, e.g. Example 35). The use of a diffusion

material, however, is well known to reduce the light output. Even small reductions in luminance are considered undesirable.

Further, Tasaki, et al. makes no suggestion as to how the presently claimed proportional variation could be achieved. Tasaki forms the cap separately from the LED and then positions the cap on the LED. It would be extremely difficult, if not impossible, to achieve a thickness which varies in proportion to an intensity of the light emitted by the light emitting component by the separate forming method of Tasaki, et al. Thus, by teaching that the cap should be formed separately and then attached to the LED, Tasaki teaches away from the present invention.

Moreover, there is no suggestion in the 09/642,901 application that in place of changing the thickness of the spacing layer, a similar result could be achieved by varying the thickness of the phosphor layer. Both these variations operate on different principles, and cannot be considered to be simply interchangeable. In the case of the 09/642,901 application, increasing the thickness of the light transmissive layer at a high intensity region results in the emitted light being spread over a larger area of the phosphor layer, thereby improving uniformity. In the case of the present application, increasing the thickness of the phosphor layer increases the amount of phosphor material which the light passes through, reducing the chance that the phosphor will become saturated. Although both applications address a similar problem, that of uneven distribution across the LED at a given voltage, the way in which the problem is solved is markedly different.

In view of the foregoing, it is respectfully requested that the double patenting rejection of claim 1 of the present application be withdrawn.

It is further requested that the double patenting rejection of claim 2 be withdrawn for the same reason. Claim 2 is dependent on claim 1. The additional recitation of claim 3 of the 09/642,901 application (that the light emitting component is selected from the group consisting of light emitting diodes and laser diodes) does not resolve the deficiencies discussed above with respect to claim 1 of the present application. Accordingly, it is respectfully requested that the double patenting rejection of claim 2 of the present application be withdrawn.

With respect to the double patenting rejection of claim 7 over claim 1 (or 2) of the copending 09/642,901 application, once again, the deficiencies discussed with respect to claim 1, above, render the claim non-obvious over the 09/642,901 application. Claim 7 calls for a layer of a light transmissive material intermediate the light emitting component and the phosphor-containing material of claim 1. Although a light transmissive layer is disclosed in the 09/642,901 application, there is no

disclosure that the phosphor-containing material layer has a thickness which varies in proportion to the intensity of the light emitted by the light emitting component, nor does Tasaki render this obvious. Accordingly, it is respectfully requested that the double patenting rejection of claim 7 of the present application be withdrawn.

The Claims Distinguish Patentably Over the References of Record

Claim 1 now calls for a light source including a light emitting component which emits light when a voltage is applied. The intensity of the light varies across the light emitting component at the applied voltage. A phosphor-containing material is positioned to receive light emitted by the light emitting component. The phosphor-containing material converts at least a portion of the light to light of a different wavelength. The phosphor-containing material has a thickness which varies in proportion to the intensity of the light emitted by the light emitting component at the applied voltage. The uniformity of color emission is improved as compared with a uniform thickness layer.

Neither of the references of record discloses such a light emitting component. The **Lowery** patent does not suggest a phosphor-containing material which has a thickness that varies in relation to an intensity of the light emitted by the light emitting component. Although Lowery does show a variation in thickness of a prior art phosphor layer **24** (Fig. 2), the layer does not vary in relation to the intensity. This is clearly seen by the fact that the prior art lamp produces light which varies in color, as discussed with relation to Fig. 1 (col. 2, lines 22-26). In some regions, the light produced is blue, while in others, a yellow light is emitted. This is clearly because the thickness of the phosphor layer is not varying in relation to the light intensity, but with some other factor, primarily the shape of the LED chip. As a result, the light emitted is not generally uniform, and is not improved as compared with a uniform thickness layer, as indicated by Lowery (col. 3, lines 7-18).

Tasaki, et al. discloses a removable cap **1, 20** for an LED **2**. The cap contains a fluorescent substance. Atlternatively, the coating may be adhered to the LED as a sheet. Tasaki suggests that the thickness of the fluorescent cap may be partially varied to diffuse the light or to change the color of the light. There is no suggestion in Tasaki of providing a cap with a thickness **which varies in proportion to an intensity of the light emitted by the light emitting component**. By varying the thickness (see, e.g., Figure 5) Tasaki focuses the light emitted by the LED along an axial direction. Further, Tasaki, et al. makes no suggestion as to how the presently claimed proportional

variation could be achieved. Tasaki forms the cap separately from the LED and then positions the cap on the LED. It would be difficult, if not impossible to achieve a thickness which varies in relation to an intensity of the light emitted by the light emitting component by the separate forming method of Tasaki, et al. Further by teaching that the cap should be formed separately and then attached to the LED, Tasaki teaches away from the present invention.

Accordingly, it is submitted that claim 1 and claims 2-9 dependent therefrom differ patentably and unobviously over the references of record.

Claim 8 was further rejected over **Kamiyama, et al.** Kamiyami discloses a die attached with a UV curable resin. However, Kamiyama does not supply the elements missing from the primary references, and thus does not render claim 8 obvious.

Claim 10 recites a light source including a phosphor-containing material having a thickness which varies in proportion to the light passing through the phosphor material at an applied voltage, the thickness being greater in regions where the intensity of the light emitted by the light emitting component is higher and lesser in regions where the intensity of the light emitted by the light emitting component is lower.

Lowery does not suggest a light source in which a phosphor-containing material has a thickness which varies in proportion to the light passing through the phosphor material at a selected voltage. The thickness of the phosphor layer of Lowery's prior art lamp does vary in thickness, but not in proportion to the intensity of the light. As a result, the light emitted is of varying color intensity, and is not generally uniform.

Further, although **Tasaki**'s cap may vary in thickness, it does not disclose varying the thickness in **proportion** to the intensity of the light. The presence of electrical connectors and so forth (see Fig. 3 of Tasaki) render the emission of light over the top surface of the LED non-uniform, not curved, peaking in the center as does Tasaki's cap.

Accordingly, it is submitted that claim 10 and claims 11 and 16 dependent therefrom differ patentably and unobviously over the references of record.

Claim 12 recites a light source with a phosphor-containing material having a thickness which is greater in regions where the intensity of the light emitted by the light emitting component is higher and lesser in regions where the intensity of the light emitted by the light emitting component is lower. The phosphor-containing material is formed by forming a layer of a phosphor-containing light curable material over the light emitting component, energizing the light emitting component for a

sufficient period of time to cure a portion of the curable material, and removing remaining uncured curable material.

Lowery and **Tasaki** make no suggestion of forming a phosphor-containing material by such a process. The phosphor layer formed from the claimed method is very different from that of Lowery and Tasaki in that the layer changes thickness in relation to the intensity of light, and avoids the color shift observed by Lowery in regions where the phosphor layer is not of appropriate thickness for the intensity of the light passing through it (either too thick or too thin). The lamp produced by the presently claimed process overcomes these problems by curing the light with the LED itself, thus providing a cured thickness which directly corresponds to the intensity of light through each region. As can be seen from FIGURE 6 of the present application, the light intensity varies markedly across the LED and thus it is not possible to reproduce this variation by conventional forming methods, such as those of Lowery or Tasaki. Tasaki's curved lens cap does not achieve the high degree of uniformity which may be achieved in the presently claimed lamp. The need for a diffusion material, such as that used by Tasaki to improve color distribution, is obviated in the present method, improving the light output of the lamp.

Because the present light source produced by the claimed process is far superior than conventionally produced lamps and has a radial uniformity of color which has not been heretofore disclosed or suggested in the prior art, it is submitted that the prior art does not disclose or suggest a lamp which is functionally equivalent to the claimed light source.

Accordingly, it is submitted that claim 12 and claims 13-15 and 17 dependent therefrom differ patentably and unobviously over the references of record.

Claim 17 was further rejected over **Kamiyama, et al.** Kamiyami discloses a die attached with a UV curable resin. However, Kamiyama does not supply the elements missing from the primary references, and thus does not render claim 17 obvious.

Claim 23 recites a light source with improved color distribution in which a phosphor containing layer is formed by a method which includes energizing the light emitting component for a sufficient period of time to cure a portion of the curable material and removing remaining uncured curable material.

Lowery makes no suggestion of forming a lamp by this method. The presently claimed lamp has superior light uniformity to the prior art lamp of Lowery, particularly when the LED output is extremely non-uniform, because the changing thickness of the phosphor layer is able to compensate for non-uniformities in the light

output from the die. The process thus results in a phosphor layer which accurately reflects the light intensity variations, and is not due simply to the shape of the die, as is Lowery's. Lowery's prior art phosphor layer does not accurately correspond to the light intensity variation and thus produces a light output which is non-uniform. The present lamp is able to achieve a high degree of uniformity not possible with either the prior art or otherwise disclosed lamps of Lowery.

Moreover, including **Tasaki's** lens cap in the lamp of Lowery would not achieve the uniformity in color distribution which can be achieved by the presently claimed lamp. As can be seen from FIGURE 6 of the present application, light distribution does not follow a uniform curve, as in Tasaki's cap of FIGURE 5. Rather, the variation is uneven and thus would be difficult if not impossible to achieve in Tasaki's cap forming method. Accordingly, the color distribution of the presently claimed device is far superior to that which could be achieved by this combination of references. Additionally, the efficiency of the lamp is improved because the phosphor layer can be at the optimal thickness across the entire surface of the LED. As a result, excessive absorption of the light in those areas where the phosphor layer is thicker than is needed is avoided.

Because the present light source produced by the claimed process is far superior than conventionally produced lamps and has a radial uniformity of color which has not been heretofore disclosed or suggested in the prior art, it is submitted that the prior art does not disclose or suggest a lamp which is functionally equivalent to the claimed light source.

Accordingly, it is submitted that claim 23 distinguishes patentably and unobviously over the references of record.

CONCLUSION

For the reasons set forth above, it is submitted that claims 1-17 and 23 distinguish patentably and unobviously over the references of record. An early allowance of all claims is earnestly solicited.

Respectfully submitted,

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VERSION OF CLAIMS WITH MARKINGS TO SHOW CHANGES MADE
January 28, 2003

Please cancel claims 18-22, without prejudice.

Please amend claims 1, 10, and 12, as follows:

1. (Twice Amended) A light source comprising:

a light emitting component which emits light <u>when a voltage is applied, an intensity of the light varying across the light emitting component at the applied voltage</u>; and

a phosphor-containing material positioned to receive light emitted by the light emitting component, the phosphor-containing material converting at least a portion of the light to light of a different wavelength, the phosphor-containing material having a thickness which varies in [relation] <u>proportion</u> to [an] <u>the</u> intensity of the light emitted by the light emitting component <u>at the applied voltage</u>, whereby the uniformity of color emission is improved as compared with a uniform thickness layer.

10. (Twice Amended) A light source comprising:

a light emitting component which emits light <u>when a voltage is applied, an intensity of the light varying across the light emitting component at the applied voltage</u>; and

a phosphor-containing material positioned to receive light emitted by the light emitting component and converting a portion of the light to light of a different wavelength, the phosphor-containing material having a thickness which varies in proportion to the light passing through the phosphor material <u>at the applied voltage</u>, the thickness being greater in regions where the intensity of the light emitted by the light emitting component is higher and lesser in regions where the intensity of the light emitted by the light emitting component is lower.

12. (Twice Amended) A light source [of] comprising:

a light emitting component which emits light; and

a phosphor-containing material positioned to receive light emitted by the light emitting component and converting a portion of the light to light of a different wavelength, the phosphor-containing material having a thickness which is greater in regions where the intensity of the light emitted by the light emitting component is

higher and lesser in regions where the intensity of the light emitted by the light emitting component is lower, the phosphor-containing material being formed from a material which includes:

a phosphor; and

a light-curable material, which is cured by light emitted by the light emitting component by forming a layer of a phosphor-containing light curable material over the light emitting component;

energizing the light emitting component for a sufficient period of time to cure a portion of the curable material; and

removing remaining uncured curable material.